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Nelakonda et al.

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(54) **TELEPHONE NUMBER USE ANALYSIS FOR GROUPING OF CONSECUTIVE TELEPHONE NUMBERS BASED ON ASSIGNMENT STATUS**

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(51) **Int. Cl.**

G06F 7/00	(2006.01)
G06Q 10/06	(2012.01)
G06Q 10/10	(2012.01)

(52) **U.S. Cl.**

CPC ***G06Q 10/06*** (2013.01); ***G06Q 10/10*** (2013.01)

(58) **Field of Classification Search**

CPC G06Q 10/06; G06Q 10/10

See application file for complete search history.

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Primary Examiner — Alex Gofman
Assistant Examiner — Michael Le

(57) **ABSTRACT**

A system may include a network device including a memory. The memory may store a first database including a plurality of records, wherein each record in the first database stores a telephone number (TN) and a status of the corresponding TN. the first database may stores information to indicate whether one of the records in the first database was updated. The memory may store a second database having a plurality of records. Each record in the second database may indicate a range of consecutive TNs from the first database having a same status. The system may include processors to run a first thread to update the one of the records in the first database. The processors may run a second thread to generate the second database from the first database in response to the stored information indicating that the one of the records in the first database was updated.

20 Claims, 13 Drawing Sheets

TELEPHONE NUMBER TABLE 302-3

	TELEPHONE NO. 402	STATUS 404	UPDATE FLAG 406	CUSTOMER 408	HISTORY 410
452-1	2018917239	AVAILABLE	NO	-	GRANTED 2011-09-01; AVAILABLE 2011-09-02
452-2	2018917240	AVAILABLE	NO	-	GRANTED 2011-09-01; AVAILABLE 2011-09-02
452-3	2018917241	AVAILABLE	NO	-	GRANTED 2011-09-01; AVAILABLE 2011-09-02
452-4	2018917242	ALLOCATED	YES	122-1	GRANTED 2011-09-01; AVAILABLE 2011-09-02
452-5	2018917243	ALLOCATED	YES	122-1	GRANTED 2011-09-01; AVAILABLE 2011-09-02
452-6	2018917244	ALLOCATED	YES	122-1	GRANTED 2011-09-01; AVAILABLE 2011-09-02
452-7	2018917245	AVAILABLE	NO	-	GRANTED 2011-09-01; AVAILABLE 2011-09-02
452-8	2018917246	AVAILABLE	NO	-	GRANTED 2011-09-01; AVAILABLE 2011-09-02
452-9	2018917247	AVAILABLE	NO	-	GRANTED 2011-09-01; AVAILABLE 2011-09-02

●
●
●

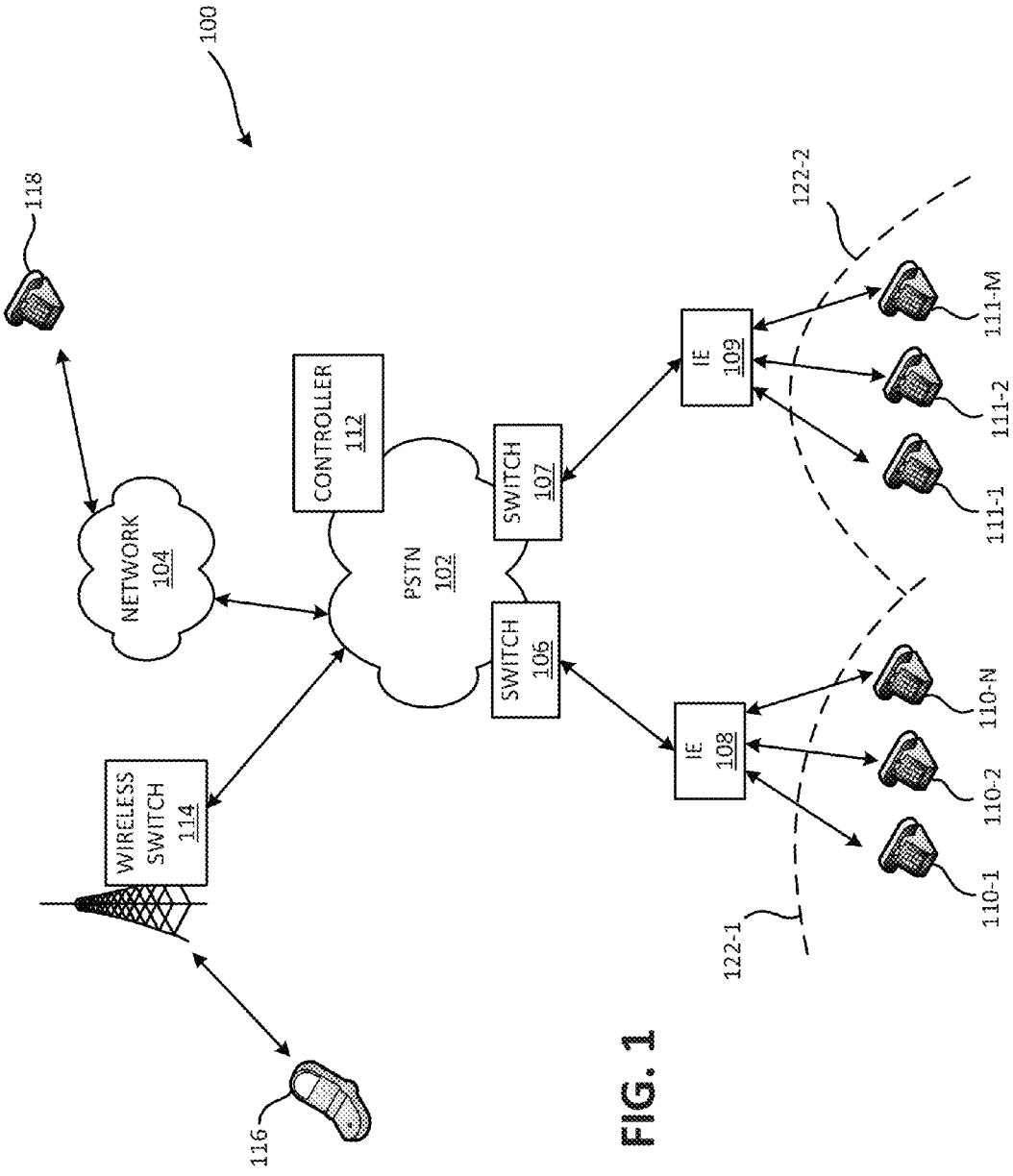

100
118
NETWORK 104
CONTROLLER 112
PSTN 102
SWITCH 107
SWITCH 106
IE 109
IE 108
WIRELESS SWITCH 114
116
122-2
122-1
111-M
111-2
111-1
110-N
110-2
110-1

FIG. 1

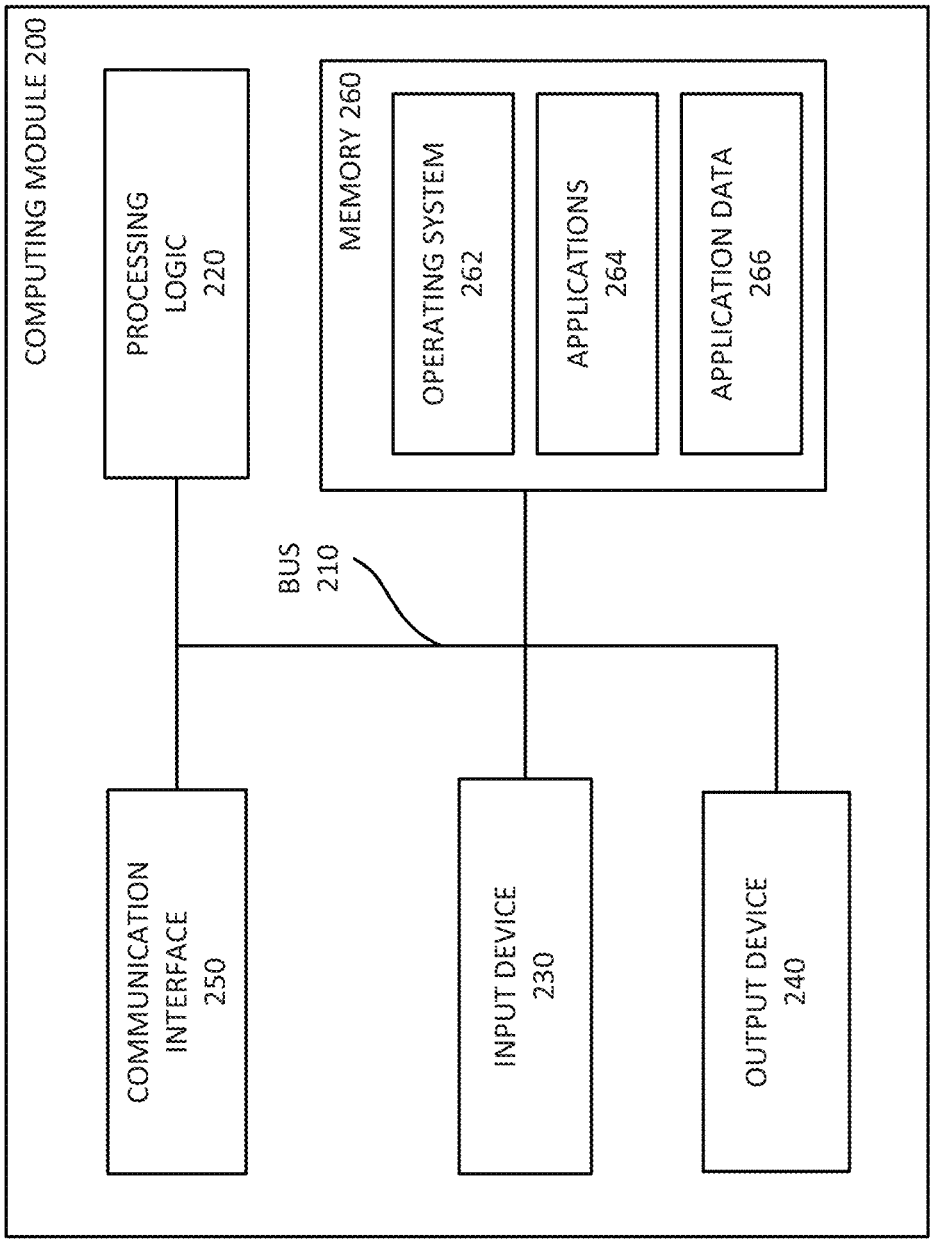

COMPUTING MODULE 200
PROCESSING LOGIC 220
MEMORY 260
OPERATING SYSTEM 262
APPLICATIONS 264
APPLICATION DATA 266
BUS 210
COMMUNICATION INTERFACE 250
INPUT DEVICE 230
OUTPUT DEVICE 240

FIG. 2

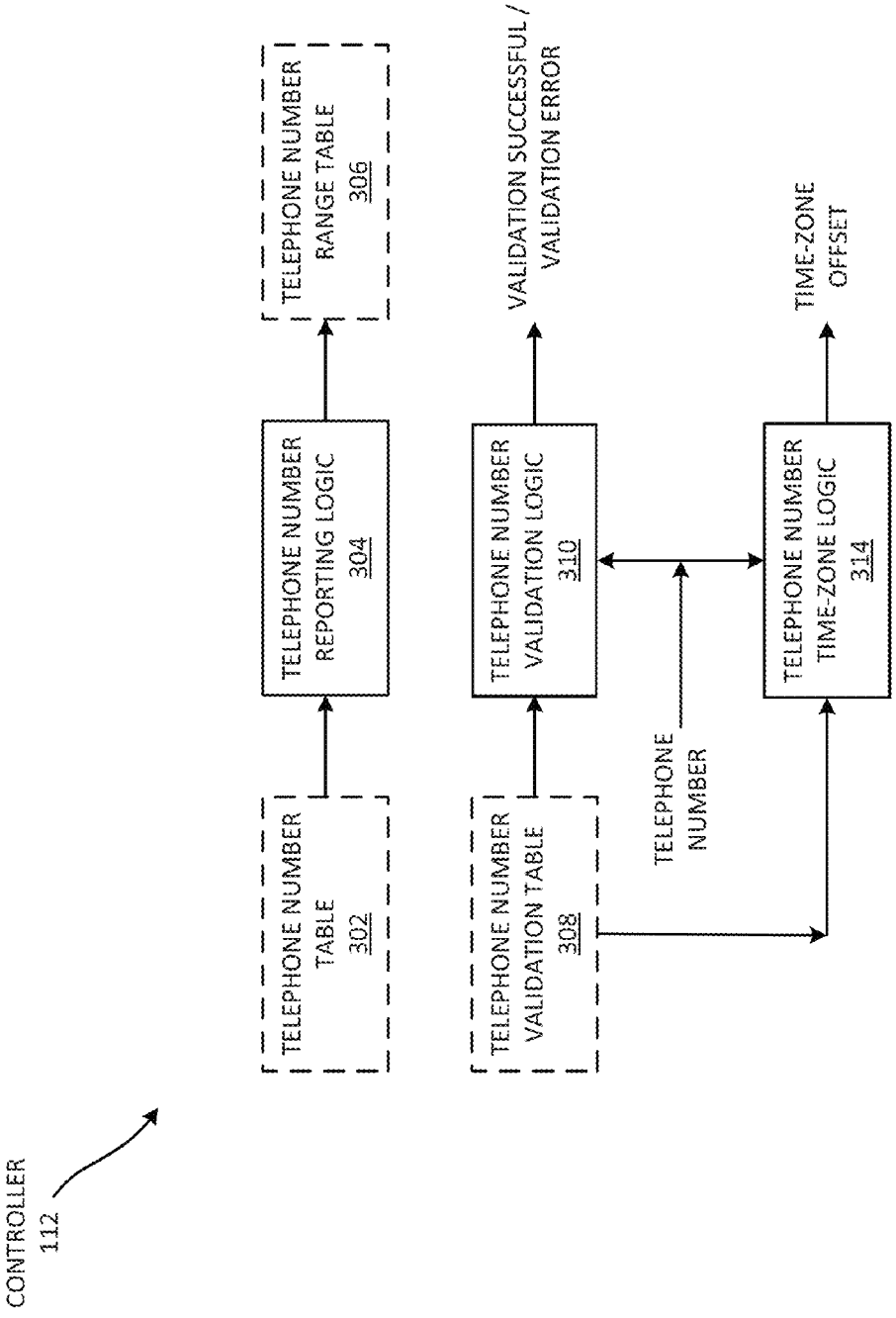

CONTROLLER
112
TELEPHONE NUMBER TABLE
302
TELEPHONE NUMBER REPORTING LOGIC
304
TELEPHONE NUMBER RANGE TABLE
306
TELEPHONE NUMBER VALIDATION TABLE
308
TELEPHONE NUMBER VALIDATION LOGIC
310
VALIDATION SUCCESSFUL / VALIDATION ERROR
TELEPHONE NUMBER
TELEPHONE NUMBER TIME-ZONE LOGIC
314
TIME-ZONE OFFSET

FIG. 3

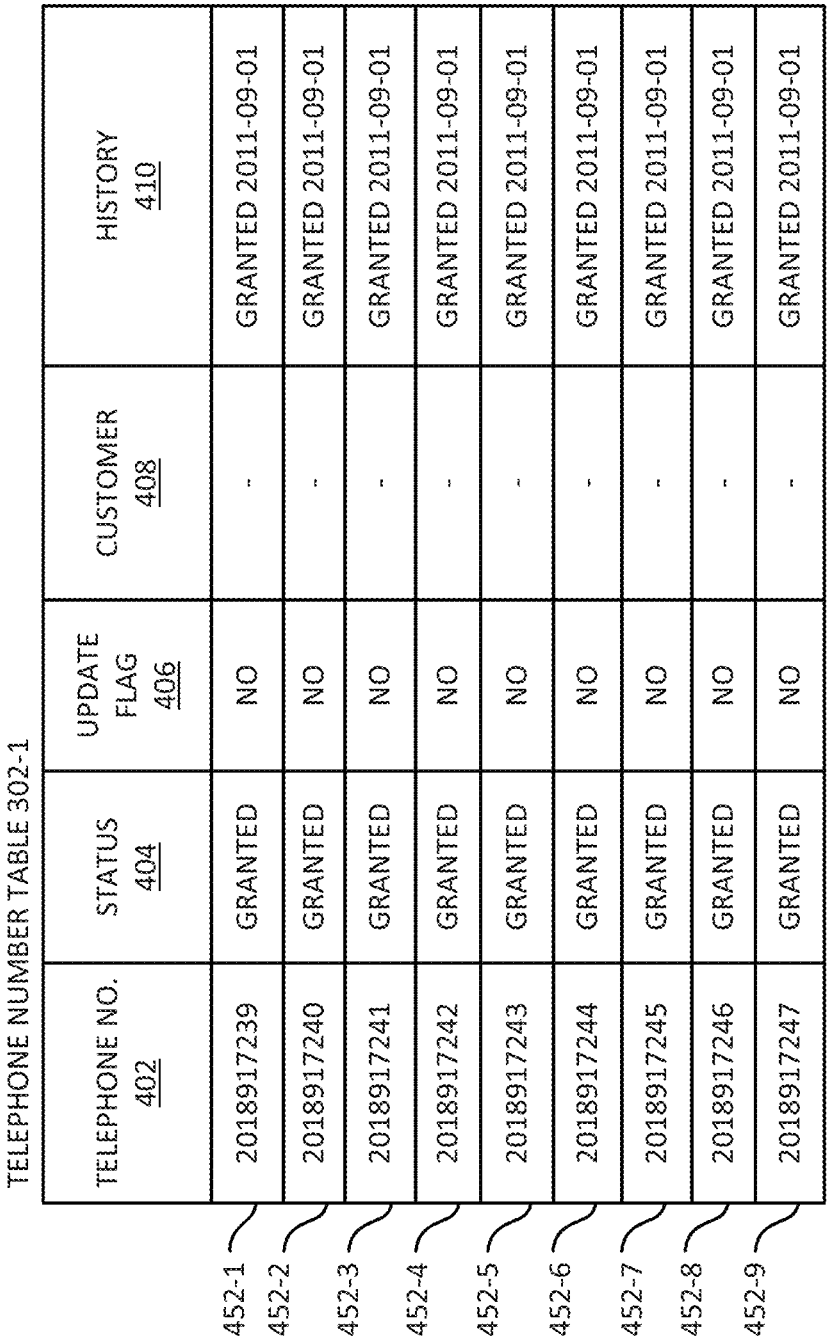
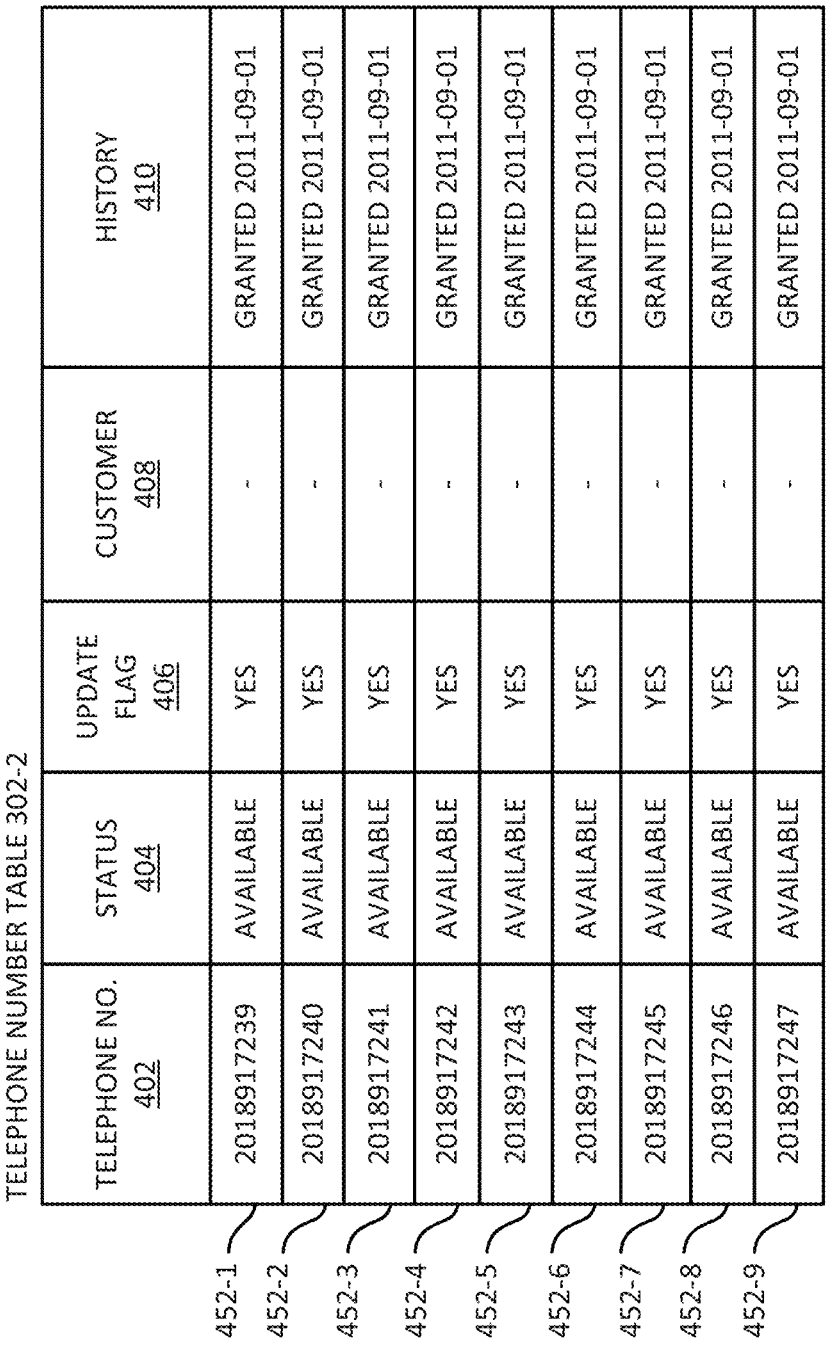
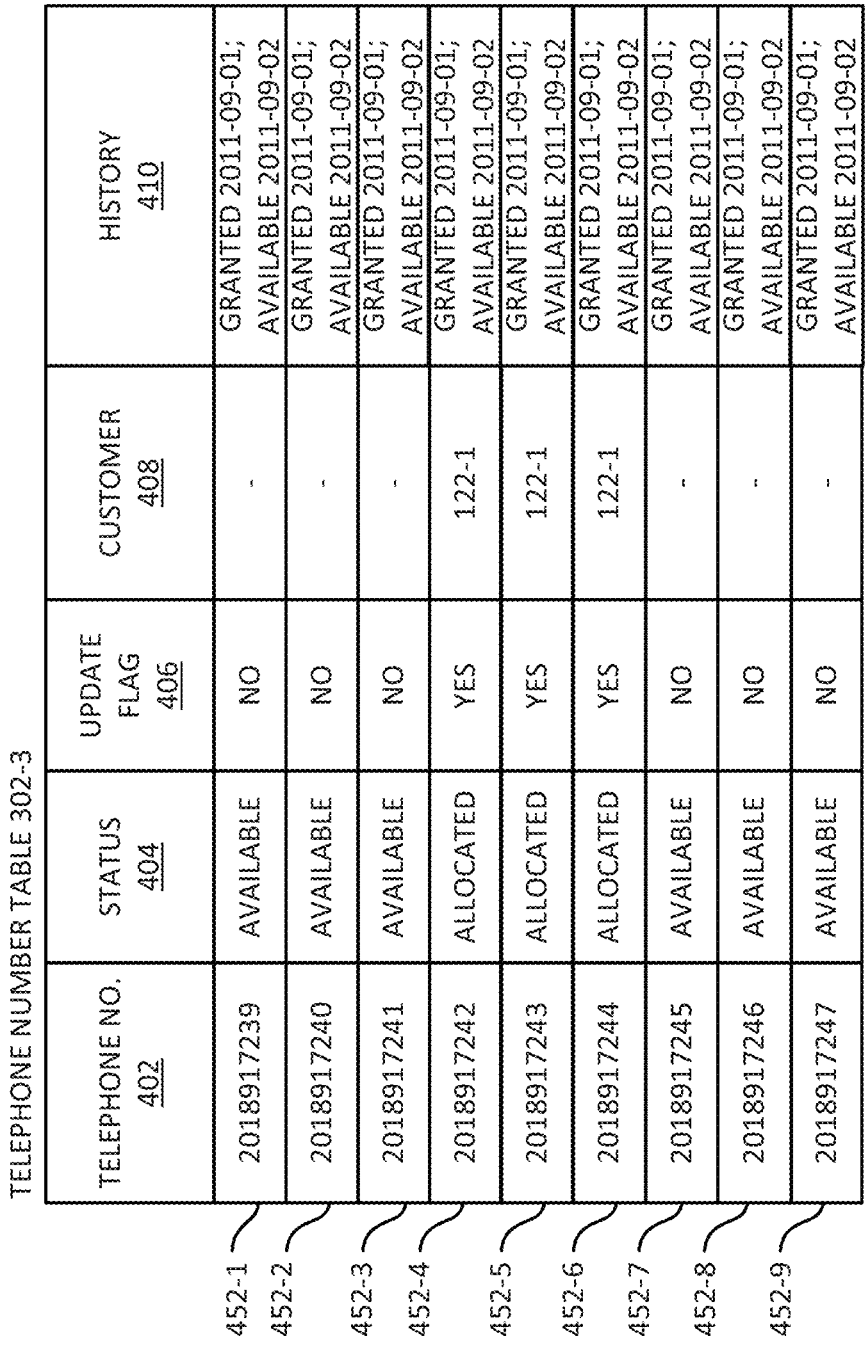

TELEPHONE NUMBER TABLE 302-1
TELEPHONE NO. 402
STATUS 404
UPDATE FLAG 406
CUSTOMER 408
HISTORY 410
452-1
452-2
452-3
452-4
452-5
452-6
452-7
452-8
452-9
2018917239 GRANTED NO - GRANTED 2011-09-01
2018917240 GRANTED NO - GRANTED 2011-09-01
2018917241 GRANTED NO - GRANTED 2011-09-01
2018917242 GRANTED NO - GRANTED 2011-09-01
2018917243 GRANTED NO - GRANTED 2011-09-01
2018917244 GRANTED NO - GRANTED 2011-09-01
2018917245 GRANTED NO - GRANTED 2011-09-01
2018917246 GRANTED NO - GRANTED 2011-09-01
2018917247 GRANTED NO - GRANTED 2011-09-01

FIG. 4A



TELEPHONE NO. 402	STATUS 404	UPDATE FLAG 406	CUSTOMER 408	HISTORY 410
2018917239	AVAILABLE	YES	-	GRANTED 2011-09-01
2018917240	AVAILABLE	YES	-	GRANTED 2011-09-01
2018917241	AVAILABLE	YES	-	GRANTED 2011-09-01
2018917242	AVAILABLE	YES	-	GRANTED 2011-09-01
2018917243	AVAILABLE	YES	-	GRANTED 2011-09-01
2018917244	AVAILABLE	YES	-	GRANTED 2011-09-01
2018917245	AVAILABLE	YES	-	GRANTED 2011-09-01
2018917246	AVAILABLE	YES	-	GRANTED 2011-09-01
2018917247	AVAILABLE	YES	-	GRANTED 2011-09-01

FIG. 4B



TELEPHONE NO. 402	STATUS 404	UPDATE FLAG 406	CUSTOMER 408	HISTORY 410
2018917239	AVAILABLE	NO	-	GRANTED 2011-09-01; AVAILABLE 2011-09-02
2018917240	AVAILABLE	NO	-	GRANTED 2011-09-01; AVAILABLE 2011-09-02
2018917241	AVAILABLE	NO	-	GRANTED 2011-09-01; AVAILABLE 2011-09-02
2018917242	ALLOCATED	YES	122-1	GRANTED 2011-09-01; AVAILABLE 2011-09-02
2018917243	ALLOCATED	YES	122-1	GRANTED 2011-09-01; AVAILABLE 2011-09-02
2018917244	ALLOCATED	YES	122-1	GRANTED 2011-09-01; AVAILABLE 2011-09-02
2018917245	AVAILABLE	NO	-	GRANTED 2011-09-01; AVAILABLE 2011-09-02
2018917246	AVAILABLE	NO	-	GRANTED 2011-09-01; AVAILABLE 2011-09-02
2018917247	AVAILABLE	NO	-	GRANTED 2011-09-01; AVAILABLE 2011-09-02

FIG. 4C

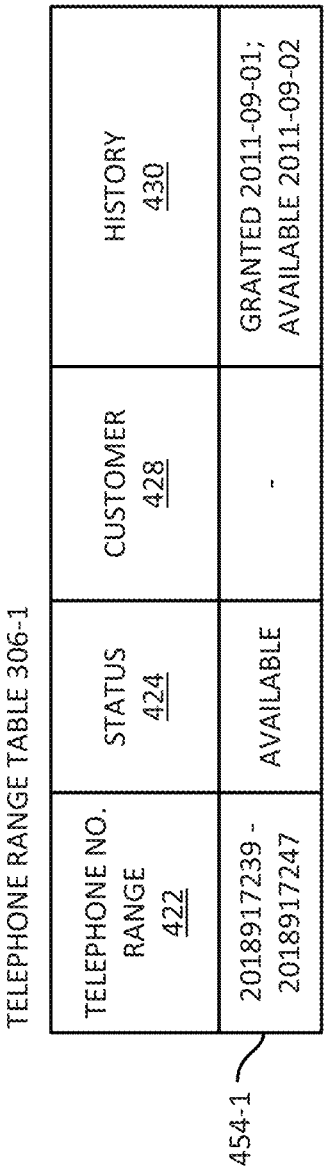

TELEPHONE RANGE TABLE 306-1
TELEPHONE NO. RANGE 422
STATUS 424
CUSTOMER 428
HISTORY 430
2018917239 - 2018917247
AVAILABLE
-
GRANTED 2011-09-01; AVAILABLE 2011-09-02
454-1

FIG. 4D

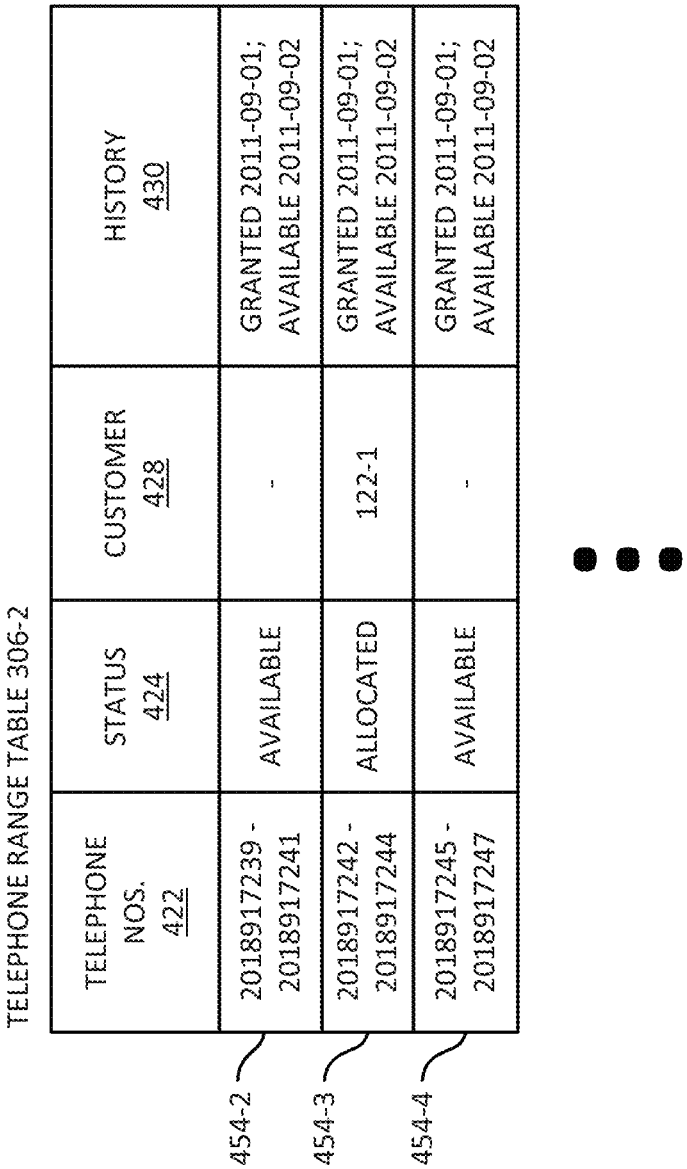
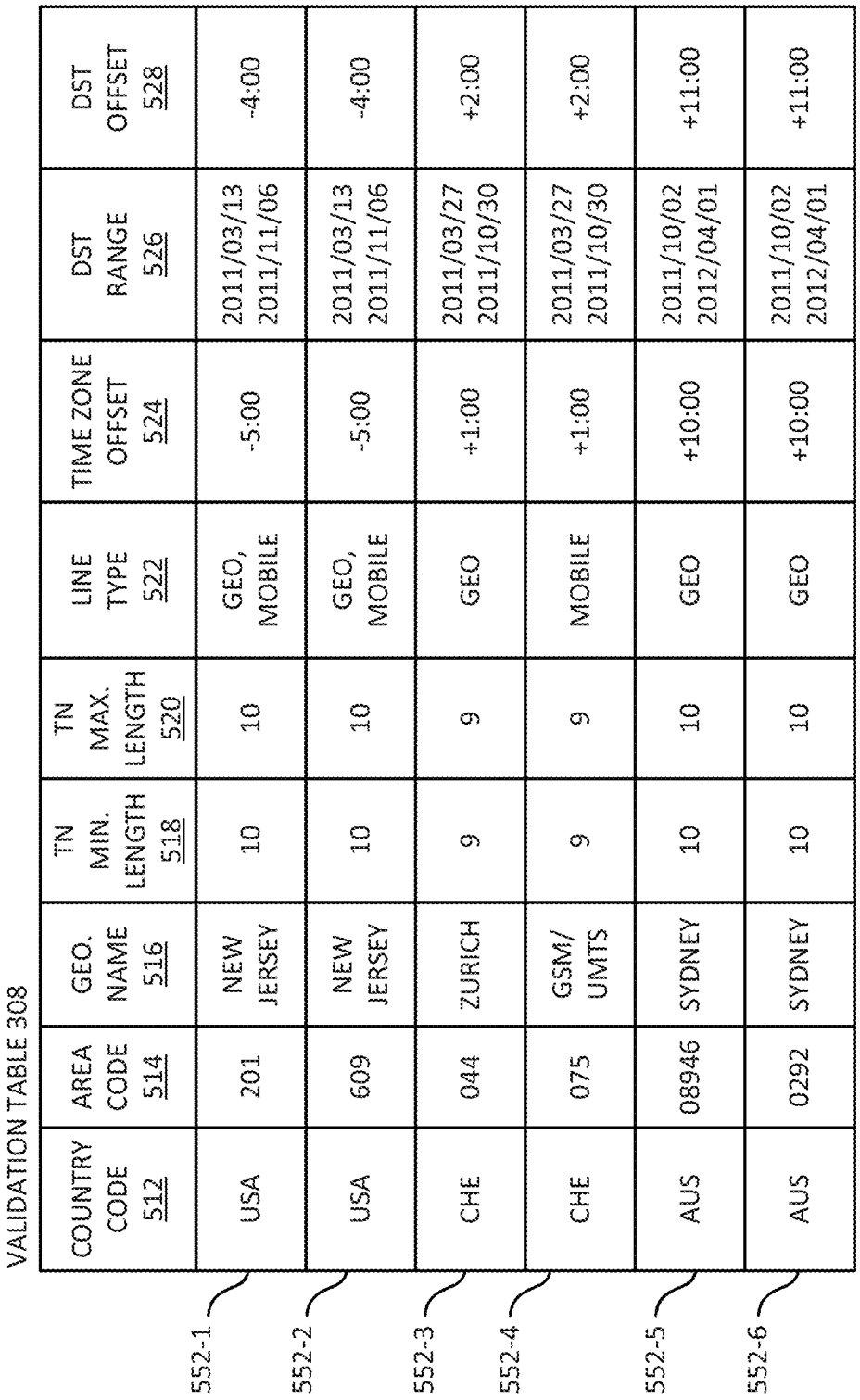

TELEPHONE RANGE TABLE 306-2
TELEPHONE NOS. 422
STATUS 424
CUSTOMER 428
HISTORY 430
2018917239 - 2018917241
AVAILABLE
-
GRANTED 2011-09-01; AVAILABLE 2011-09-02
2018917242 - 2018917244
ALLOCATED
122-1
GRANTED 2011-09-01; AVAILABLE 2011-09-02
2018917245 - 2018917247
AVAILABLE
-
GRANTED 2011-09-01; AVAILABLE 2011-09-02
454-2
454-3
454-4

FIG. 4E



VALIDATION TABLE 308

	COUNTRY CODE 512	AREA CODE 514	GEO. NAME 516	TN MIN. LENGTH 518	TN MAX. LENGTH 520	LINE TYPE 522	TIME ZONE OFFSET 524	DST RANGE 526	DST OFFSET 528
552-1	USA	201	NEW JERSEY	10	10	GEO, MOBILE	-5:00	2011/03/13 2011/11/06	-4:00
552-2	USA	609	NEW JERSEY	10	10	GEO, MOBILE	-5:00	2011/03/13 2011/11/06	-4:00
552-3	CHE	044	ZURICH	9	9	GEO	+1:00	2011/03/27 2011/10/30	+2:00
552-4	CHE	075	GSM/ UMTS	9	9	MOBILE	+1:00	2011/03/27 2011/10/30	+2:00
552-5	AUS	08946	SYDNEY	10	10	GEO	+10:00	2011/10/02 2012/04/01	+11:00
552-6	AUS	0292	SYDNEY	10	10	GEO	+10:00	2011/10/02 2012/04/01	+11:00

FIG. 5

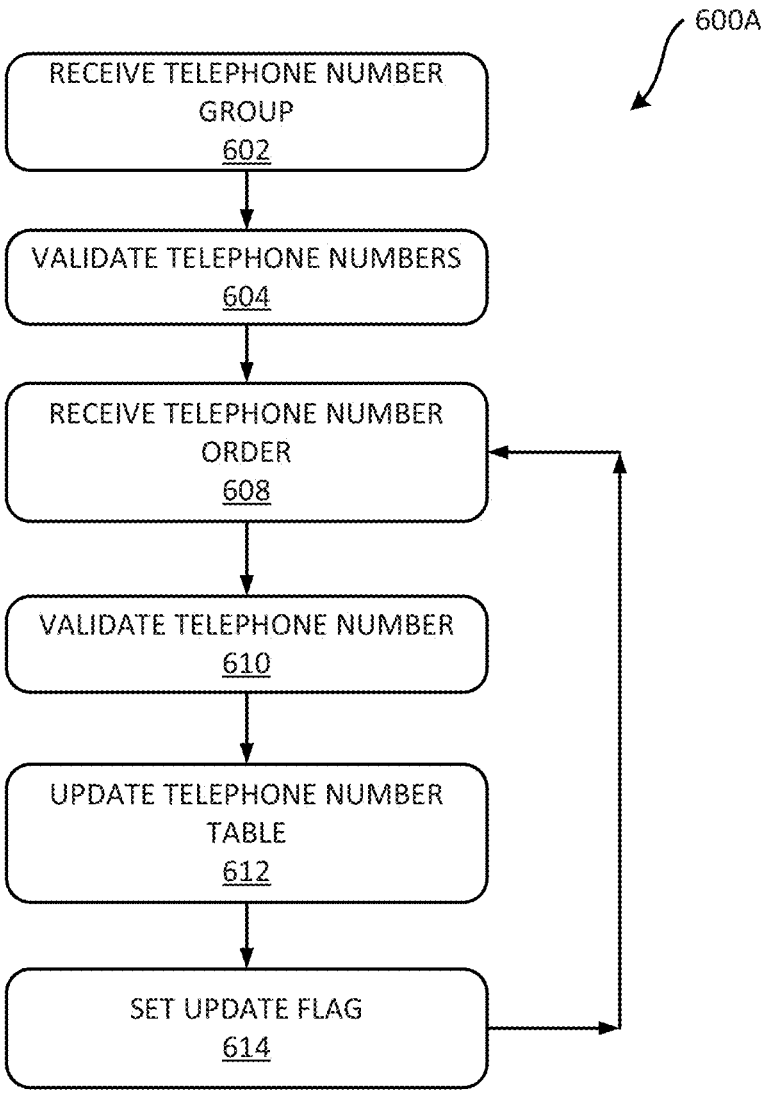

600A
RECEIVE TELEPHONE NUMBER GROUP
602
VALIDATE TELEPHONE NUMBERS
604
RECEIVE TELEPHONE NUMBER ORDER
608
VALIDATE TELEPHONE NUMBER
610
UPDATE TELEPHONE NUMBER TABLE
612
SET UPDATE FLAG
614

FIG. 6A

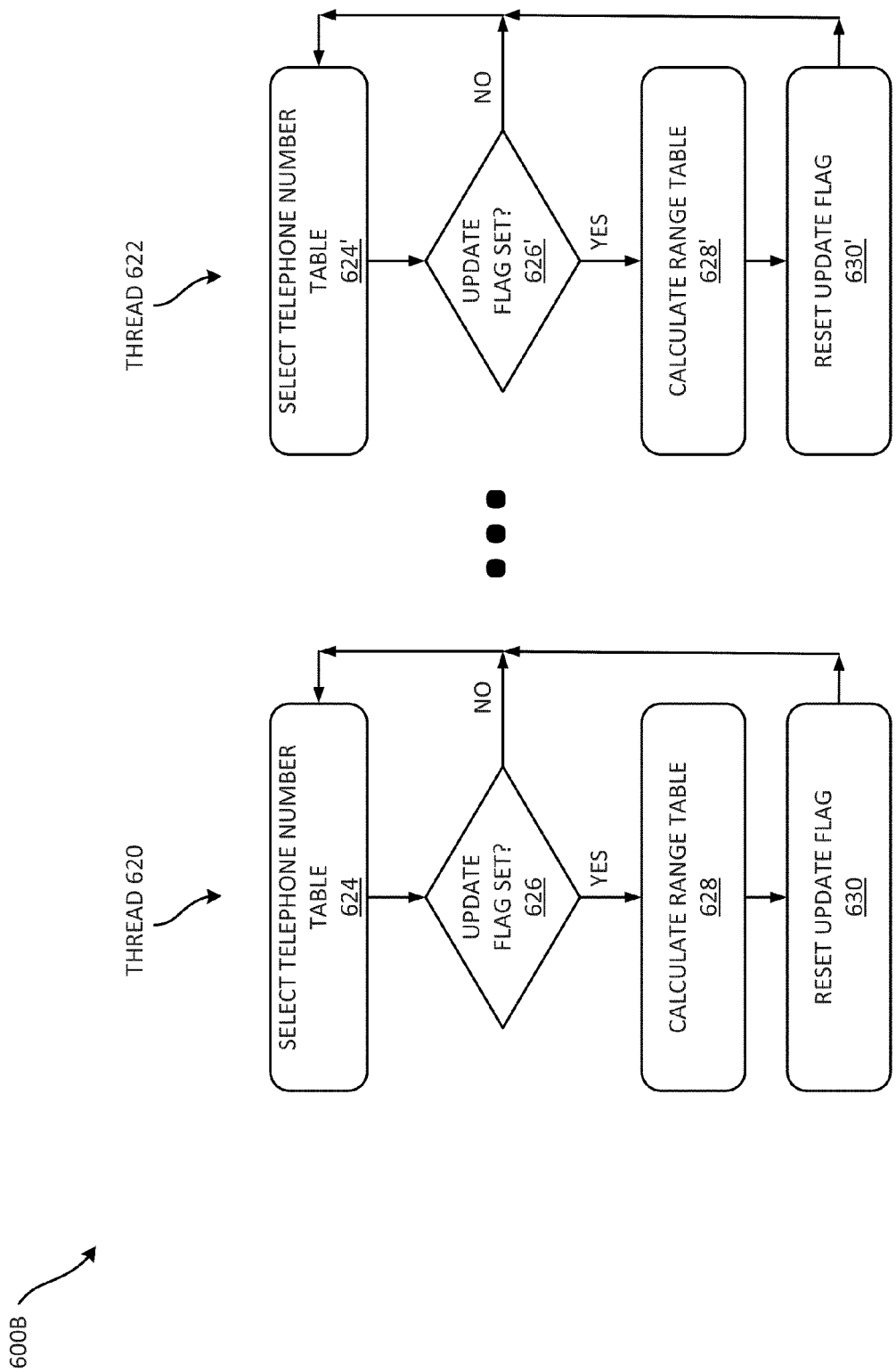

600B
THREAD 620
SELECT TELEPHONE NUMBER TABLE 624
UPDATE FLAG SET? 626
NO
YES
CALCULATE RANGE TABLE 628
RESET UPDATE FLAG 630
THREAD 622
SELECT TELEPHONE NUMBER TABLE 624'
UPDATE FLAG SET? 626'
NO
YES
CALCULATE RANGE TABLE 628'
RESET UPDATE FLAG 630'

FIG. 6B

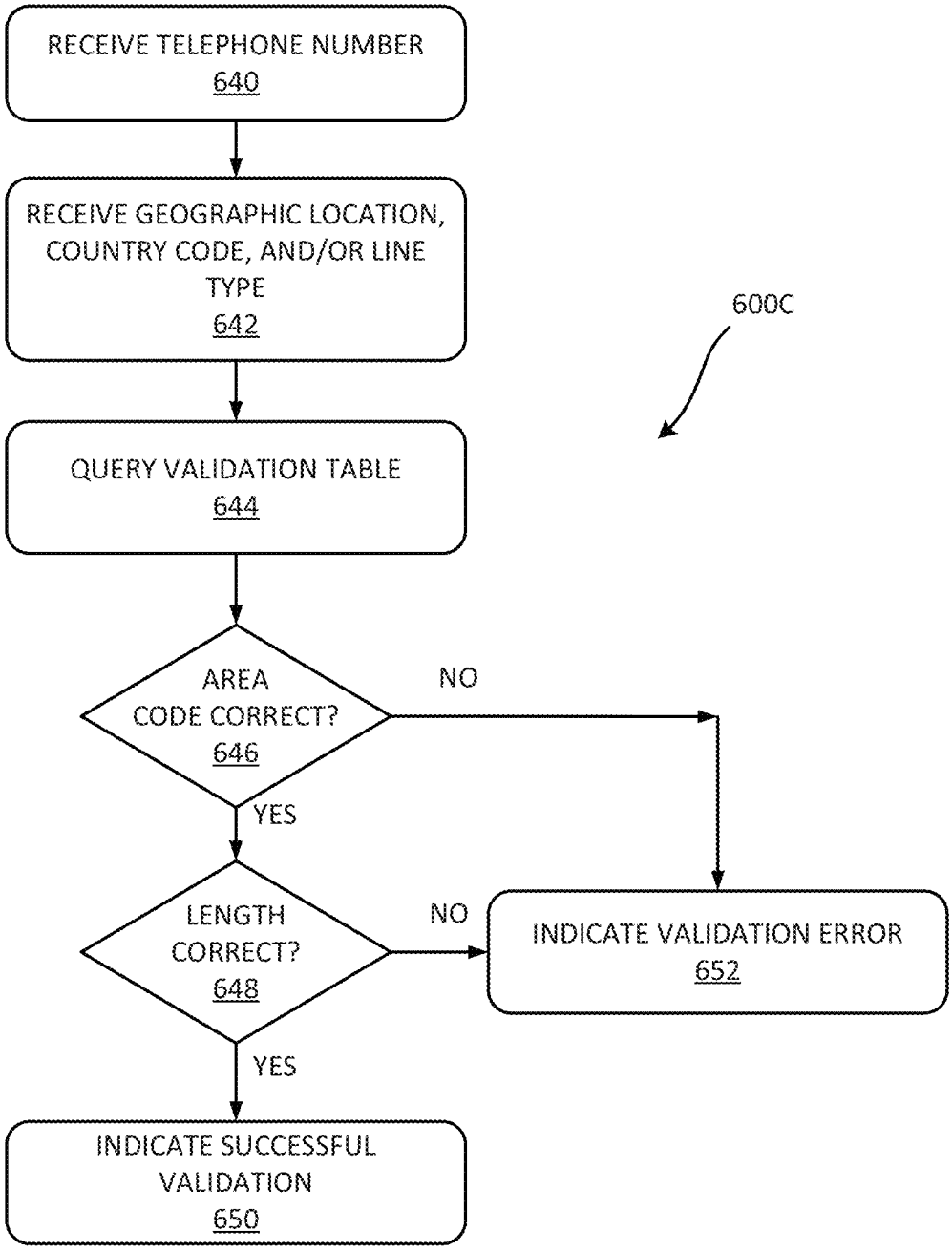

RECEIVE TELEPHONE NUMBER
640
RECEIVE GEOGRAPHIC LOCATION, COUNTRY CODE, AND/OR LINE TYPE
642
600C
QUERY VALIDATION TABLE
644
AREA CODE CORRECT?
646
NO
YES
LENGTH CORRECT?
648
NO
INDICATE VALIDATION ERROR
652
YES
INDICATE SUCCESSFUL VALIDATION
650

FIG. 6C

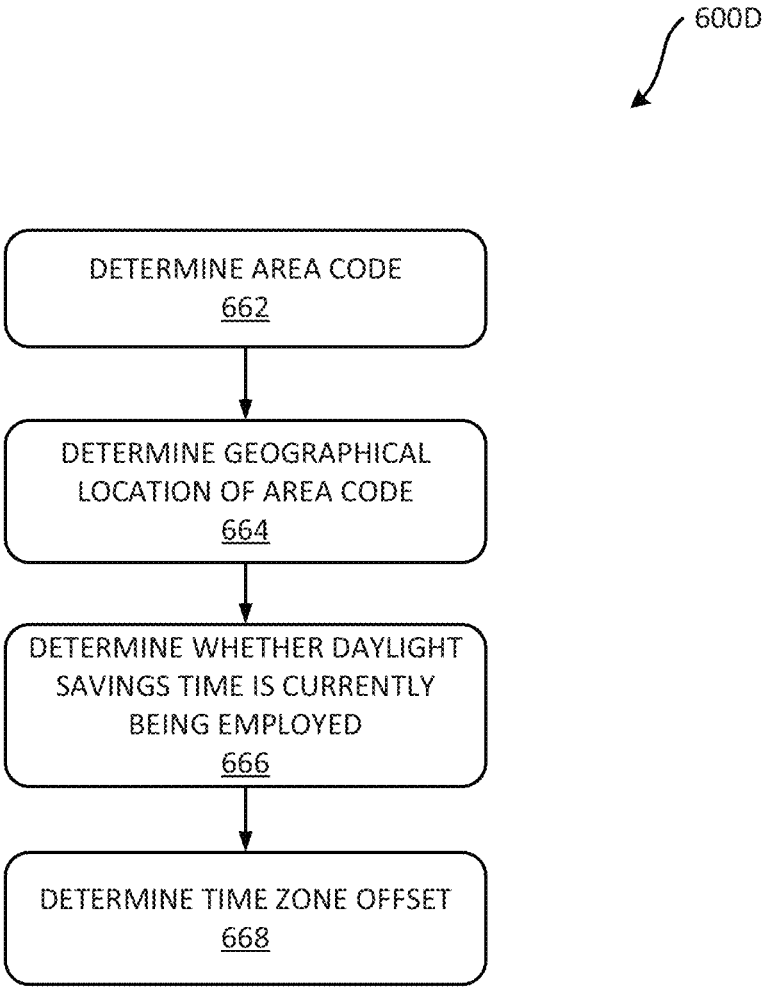

600D
DETERMINE AREA CODE
662
DETERMINE GEOGRAPHICAL LOCATION OF AREA CODE
664
DETERMINE WHETHER DAYLIGHT SAVINGS TIME IS CURRENTLY BEING EMPLOYED
666
DETERMINE TIME ZONE OFFSET
668

FIG. 6D

TELEPHONE NUMBER USE ANALYSIS FOR GROUPING OF CONSECUTIVE TELEPHONE NUMBERS BASED ON ASSIGNMENT STATUS

BACKGROUND INFORMATION

A private branch exchange (PBX) is a telephone exchange that may serve a particular business or office, as opposed to an exchange that a common carrier or telephone company may operate for the general public. A PBX, for example, may connect the internal telephones of a private organization and also may connect the internal telephones to a public switched telephone network (PSTN) via trunk lines. A Central exchange (Centrex) is a PBX-like service providing switching at a central office (e.g., at the telephone company) rather than at the private organization's premises. In this case, the telephone company may own and manage the communications equipment (e.g., a switch) and software to implement the Centrex service. The telephone company may sell the services to the private organization (e.g., the customer).

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram of an exemplary network for implementing embodiments described herein;

FIG. **2** is a block diagram of exemplary components of a computing module;

FIG. **3** is a block diagram of exemplary components of the controller of FIG. **1**;

FIGS. **4**A, **4**B, and **4**C are block diagrams of exemplary telephone number tables;

FIGS. **4**D and **4**E are block diagrams of exemplary telephone number range tables;

FIG. **5** is a block diagram of an exemplary telephone number validation table;

FIG. **6**A is a flowchart of a process for the intake of blocks of telephone numbers in one embodiment;

FIG. **6**B is a flowchart of a process for generating a telephone number range table when updating telephone number tables in one embodiment;

FIG. **6**C is a flowchart of a process for validating telephone numbers in one embodiment; and

FIG. **6**D is a flowchart of a process for determining the time-zone offset for a telephone number.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The following detailed description refers to the accompanying drawings. The same reference numbers in different drawings may identify the same or similar elements. Also, the following detailed description is exemplary and explanatory only and is not restrictive of the invention, as claimed.

PBXs and Centrex groups may be assigned blocks of telephone numbers (TNs). Thus, a university may, for example, be assigned a block of 10,000 TNs for its 9,000 current students to use. Individuals may also be assigned TNs. TNs, however, are a limited resource and an excessive number of unused TNs by many PBXs or Centrex groups may unduly limit the use of TNs by other customers. A national regulator (e.g., the Federal Communications Commission (FCC)) may regulate the use of TNs to limit the amount of numbers that are set aside for use by a customer but are not being used to provide service on a regular basis.

Embodiments described herein allow for databases of TNs to be updated while also allowing for the database to be analyzed for display and reporting. In one embodiment, TNs may also be validated based on information (e.g., format information) stored in a database, without having to update code for new areas or countries. In another embodiment, the time-zone offset (e.g., offset from Greenwich Mean Time (GMT)) may be calculated based on known information about a telephone number.

FIG. **1** is a diagram of an exemplary network **100** for implementing embodiments described herein. Network **100** may include a public switch telephone network (PSTN) **102**, a network **104**, switches **106** and **107**, intermediary equipment (IE) **108** and **109**, telephones **110-1** through **110**-N (collectively phones **110**, individually phone **110**-*x*), telephones **111-1** through **111**-M (collectively phones **111**), a controller **112**, a wireless switch **114**, a mobile device **116**, and a telephone **118**.

Phones **110** may be associated with a first customer premises **122-1** and a PBX or Centrex group assigned to a first block of TNs. Phones **110** may include any type of residential, business, and/or mobile phone that may be connected to PSTN **102** through intermediary equipment **108** and switch **106**. In one embodiment, phones **110** may each be associated with one or more TNs in the block of TNs associated with the PBX or Centrex group associated with customer premises **122-1**.

Intermediary equipment **108** may include a telephone network box, telephone poles, an entrance bridge, a digital concentrator, fiber-optic cables, digital equipment, etc. Switch **106** may include a class 5 telephone switch, such as a 5ESS switch made by Alcatel-Lucent. Controller **112** may provide administration and management of switch **106**. Switch **106** may include switching modules to switch signals (e.g., telephone calls) by interpreting dialed digits and connecting calls between telephones, for example.

Controller **112** may define groups or blocks of TNs to assign to PBXs and/or Centrex groups, may analyze the use of the assigned TNs, and may remove TNs from blocks of TNs assigned to PBXs and/or Centrex groups.

Wireless switch **114** may control traffic and signaling with a mobile device (e.g., mobile device **116**). Wireless switch **114** may include an antenna to transmit and receive signals to and from mobile device **116**. Mobile device **116** may include a mobile phone, a tablet computer, a laptop, or another portable communication device. Even though mobile device **116** is not in customer premises **122-1**, it may still be associated with the same PBX or Centrex group as phones **110**, for example.

Network **104** may include one or more packet switched networks, such as an Internet protocol (IP) based network, a local area network (LAN), a wide area network (WAN), a personal area network (PAN), an intranet, the Internet, or another type of network that is capable of transmitting data. Network **104** may also include a circuit-switched network, such as a PSTN (similar to PSTN **102**) for providing telephone services for traditional telephones. Phone **118** may be coupled to network **104** and may use a packet-based protocol for establishing calls and transmitting media (e.g., session initiation protocol (SIP) and/or real-time protocol (RTP)). While phone **118** may not be physically located at customer premises **122-1**, phone **118** may be associated with the same PBX or Centrex group as phones **110**, for example.

Phones **111** may be associated with a second customer premises **122-2** and a PBX or Centrex group assigned to a second block of TNs different than the block of TNs associated with first customer premises **122-1**. Phones **111** may be connected to PSTN **102** through intermediary equipment **109** and switch **107**. In one embodiment, phones **111** may each be associated with one or more TNs in the block of TNs associ-

ated with the PBX or Centrex group associated with second customer premises **122-2**. Phones **111**, intermediary equipment **109**, and switch **107** may be configured and operate similarly to phones **110**, intermediary equipment **108**, and switch **106** discussed above.

The exemplary configuration of devices in network **100** is illustrated for simplicity. Network **100** may include more devices, fewer devices, or a different configuration of devices than illustrated in FIG. **1**. For example, network **100** may include thousands or millions of customer premises, each associated with a PBX or Centrex group and telephones. In some embodiments, the functions performed by two or more devices may be performed by any one device. Likewise, in some embodiments, the functions performed by any one device may be performed by multiple devices. Further, the connections shown in FIG. **1** are exemplary. In other embodiments, additional connections that are not shown in FIG. **1** may exist between devices (e.g., each device may be connected to every other device).

Devices in network **100** may include one or more computing modules. FIG. **2** is a block diagram of exemplary components of a computing module **200**. Computing module **200** may include a bus **210**, processing logic **220**, an input device **230**, an output device **240**, a communication interface **250**, and a memory **260**. Computing module **200** may include other components (not shown) that aid in receiving, transmitting, and/or processing data. Moreover, other configurations of components in computing module **200** are possible.

Bus **210** includes a path that permits communication among the components of computing module **200**. Processing logic **220** may include any type of processor or microprocessor (or families of processors or microprocessors) that interprets and executes instructions. In other embodiments, processing logic **220** may include an application-specific integrated circuit (ASIC), a field-programmable gate array (FPGA), etc.

Input device **230** may allow computing module **200** to input information (e.g., from a user) into computing module **200**. Input device **230** may include a keyboard, a mouse, a pen, a microphone, a remote control, a touch-screen display, etc. Some devices, such as switch **106**, may be managed remotely (e.g., are "headless") and may not include a keyboard, etc.

Output device **240** may output information (e.g., to the user). Output device **240** may include a display, a printer, a speaker, etc. For example, controller **112** may include a display that includes a liquid-crystal display (LCD) for displaying menus and content to the user. Headless devices, such as switch **106**, may be managed remotely and may not include a display, etc.

Input device **230** and output device **240** may allow the user to activate and interact with a particular service or application, such as an application to manage TNs in PBX or Centrex groups. Input device **230** and output device **240** may allow the user to receive and view a menu of options and select from the menu options. The menu may allow the user to select various functions or services associated with applications executed by computing module **200**.

Communication interface **250** may include a transceiver that enables computing module **200** to communicate with other devices. Communication interface **250** in switch **106**, for example, may include a number of switching modules to perform switching operations by interpreting dialed digits and connecting calls between telephones. Communication interface **250** may include a transmitter that, for example, converts baseband signals to radio frequency (RF) signals. Communication interface **250** may include a receiver that, for example, converts RF signals to baseband signals. Communication interface **250** may be coupled to an antenna for transmitting and receiving signals. Communication interface **250** may include a network interface card, e.g., an Ethernet or WiFi card, for wired or wireless communications.

Memory **260** may store, among other things, information and instructions (e.g., applications **264** and operating system (OS) **262**) and data (e.g., application data **266**) for use by processing logic **220**. Memory **260** may include a random access memory (RAM) or another type of dynamic storage device, a read-only memory (ROM) device or another type of static storage device. Memory **260** may include a magnetic or optical recording medium and its corresponding drive (e.g., a hard disk drive).

OS **262** may include software instructions for managing hardware and software resources of computing module **200**. For example, OS **262** may include Unix, Linux, OS X, Solaris, an embedded operating system, etc. Applications **264** and application data **266** may provide network services or include applications, depending on the device in which the particular computing module **200** is found. For example, controller **112** may include an application to manage TNs in PBX or Centrex groups.

Computing module **200** may perform the operations described herein in response to processing logic **220** executing software instructions contained in a non-transient computer-readable medium, such as memory **260**. The software instructions may be read into memory **260** from another computer-readable medium or from another device via communication interface **250**. The software instructions contained in memory **260** may cause processing logic **220** to perform processes that are described herein.

As discussed above, in one embodiment, controller **112** may control and handle blocks of TNs for PBX or Centrex groups. FIG. **3** is a block diagram of exemplary components of controller **112** (e.g., functions performed by application **264** in processing logic **220** or stored in memory **260** of controller **112**). Controller **112** may include a telephone number table **302**, telephone number reporting logic **304**, a telephone number range table **306**, a telephone number validation table **308**, telephone number validation logic **310**, and telephone number time zone logic **314**. Some components shown in FIG. **3** may also be stored in other devices in network **100**. For example, TN table **302** may also or alternatively be stored in switch **106**. TN table **302**, range table **306**, and validation table **308** may each also be considered a "database." Further, tables **302**, **306**, and **308** may each be stored in a single database or different databases.

TN table **302** stores information related to telephone numbers, such as the customer associated with TNs and the status of the TNs. FIG. **4**A is a block diagram of an exemplary TN table **302-1**. As used here, a "-1" suffix indicates one instance of TN table **302** or snapshots of TN table **302** at different times. Other suffixes (e.g., "-2" or "-3") indicate other instances of TN table **302** or snapshots of TN table **302** at different times. For example, FIG. **4**B shows TN table **302-2** (e.g., TN table **302** at a different point in time), and FIG. **4**C shows TN table **302-3** (e.g., TN table **302** at a different point in time).

A record (e.g., an entry) **452**-*x* in TN table **302** may associate a telephone number with a customer (e.g., a PBX or Centrex group) and may provide the status for the corresponding telephone number. As shown in FIG. **4**A, TN table **302-1** may include a telephone number field **402**, a status field **404**, an update flag field **406**, a customer field **408**, and a history field **410**. TN table **302** may include additional, different, or fewer fields than illustrated in FIG. **4**A.

TN field **402** specifies a TN associated with the information stored in the other fields (e.g., fields **404**-**410**). An exemplary value in TN field **404** is "2018917239" in record **452-1**. While TN field **402** shows consecutive TNs in records **452-1** through **452-9**, the numbers in TN table **302** do not have to be consecutive. For example, a TN may be removed from TN table **302** and returned to the regulator.

Status field **404** specifies the status (e.g., granted, free, available, allocated, working, etc.) A "granted" TN indicates a TN that has been granted to the carrier from a national regulator, for example, but is not yet available for a customer to use. After a TN has been granted to a carrier, information about that TN may be propagated to network switches of other carriers so that when the TN is called, the call will be routed to the correct carrier, for example. An "available" TN indicates a TN that is ready to be assigned or allocated to a customer. An "allocated" or "working" TN indicates a TN that has been assigned to a customer and, when called, rings a telephone, such as telephone **110**-*x*.

Update flag field **406** indicates whether information in any of the other corresponding fields (e.g., status field **404** or customer field **408**) has been updated or changed. This information in flag field **406** may be monitored by processes that analyze and generate reports about the information stored in TN table **302**. For example, a YES in update flag field **406** of record **452-4** may prompt a process that analyzes the TNs in TN table **302**. After the analysis, the process may reset update flag field **406** of record **452-1** to NO. In one embodiment rather than associating each record **452**-*x* with an update flag field **406**, the entire TN table **302** may be associated with a single update flag field that is switched from "NO" to "YES" when any record **452**-*x* is updated. In this way, a process may run to analyze the information in TN table **302** whenever this flag is switched from "NO" to "YES."

Customer field **408** may include a value to identify (e.g., uniquely identify) a customer (e.g., a customer, a PBX group, a Centrex group, etc.). TN table **302-1** and TN table **302-2** do not specify any customer for any TNs. TN table **302-3**, on the other hand, specifies that the customer associated with customer premises **122-1** is associated with TNs 2018917242, 2018917243, and 2018917244, for example.

History field **410** may store historical information about the corresponding TN. For example, history field **410** may store the periods of time during which the corresponding TN has been allocated, the customer associated with the TN, etc. As such, history field **410** may store previous customer information to which the TN was previously allocated.

One characteristic of TN table **302**, in one embodiment, is that each TN is associated with its own record or entry in the table. In this embodiment, each TN may have properties of its own (e.g., its own status field **404**, update flag field **406**, customer field **408**, and/or history field **410**). As discussed below, range table **306** may group consecutive TNs that have similar properties.

Returning to FIG. **3**, reporting logic **304** may analyze the data in TN table **302** to display information and report on the information. In one embodiment, reporting logic **304** generates range table **306**. Range table **306** may group consecutive TNs (e.g., ranges of TNs) that have the same or similar properties. Reporting logic **304** is discussed in more detail below with respect to FIGS. **6**A and **6**B. FIG. **4**D is a block diagram of range table **306-1**. As used here, a "-1" suffix indicates one instance of range table **306** or snapshots of range table **306** at different times. Other suffixes (e.g., "-2") indicate other instances of range table **306** or snapshots of range table **306** at a different times. For example, FIG. **4**E shows range table **306-2** (e.g., range table **306** at a different point in time).

A record (e.g., an entry) **454**-*x* in range table **306-1** may associate a range of TNs with a customer (e.g., a PBX or Centrex group) and may provide status and history information for the corresponding range of TNs. As shown in FIG. **4**D, range table **306-1** may include TN range field **422**, a status field **424**, a customer field **428**, and a history field **430**. Range table **306-1** may include additional, different, or fewer fields than illustrated in FIG. **4**D.

TN range field **422** may store the same information as described above for TN field **402**, but range field **422** may specify two TNs: a start TN and an end TN. The start TN and the end TN specify a range of TNs associated with the information stored in status field **424**, customer field **428**, and history field **430**. For example, record (e.g., entry **454-1**) indicates a range of TNs from 2018917239 to 2018917247.

Status field **424**, customer field **428**, and history field **430** may all store information similar to the information discussed above for status field **404**, customer field **408**, and history field **410** of TN table **302**. The information stored in status field **424**, customer field **428**, and history field **430** correspond to the TNs stored in TN range field **422**.

Returning to FIG. **3**, validation table **308** stores information to validate (e.g., verify the proper format) of TNs. Validation logic **310** uses the information in validation table **308** to validate TNs. Validation logic **310** is discussed below in more detail with respect to FIG. **6**C. FIG. **5** is a block diagram of exemplary validation table **308**. Validation table **308** may include a country code field **512**, an area code field **514**, a geographic name field **516**, a TN minimum length field **518**, a TN maximum length field **520**, a line type field **522**, a time-zone offset field **524**, a daylight saving time (DST) range field **526**, and a DST offset field **528**. Validation table **308** may include additional, different, or fewer fields than illustrated in FIG. **5**.

Country code field **512** may specify the country for which the information in the remaining fields of validation table **308** apply. For example, record **552-1** (e.g., record **552-1**) specifies "USA" (e.g., the United States of America) as the country. Area code field **514** specifies the numeric code that is associated with a particular geographic region or group of TNs, for example. Geographic name field **516** specifies the name of the corresponding geographic region. For example, record **552-1** specifies New Jersey as the geographic region corresponding to the area code "201" specified in area code field **514**.

TN minimum length field **518** specifies the minimum length allowed for a TN for the corresponding country code, area code, geographic region, etc. TN maximum length field **520** specifies the maximum length allowed for a TN that meets the other criteria in a corresponding record (e.g., country code field **512**, area code field **514**, geographic name field **516**). Line type field **522** specifies the type of telephone line associated with the corresponding record (e.g., the corresponding area code). For example, record **552-4** specifies that the area code 075 for the country Switzerland (CHE) corresponds to TNs for mobile devices. On the other hand, record **552-3** for the area code 044 for Switzerland (CHE) indicates that the TNs correspond to geographic (e.g., "land" or "fixed") lines.

Time-zone offset field **524** specifies the time-zone offset from Greenwich Mean Time (GMT) that corresponds to the geographic area (e.g., specified in geographic name field **516**) or the area code (e.g., specified in area code field **514**). DST offset field **528** specifies the time offset from GMT during the daylight saving time period specified in DST range field **526**. DST range field **526** specifies the time periods during which daylight saving time applies for the corresponding record

(e.g., for the place specified in geographic name field **516**, area code field **514**, and/or country code **512**). For example, from Oct. 2, 2011 to Apr. 1, 2012, daylight saving time applies for Australia area code 08946 for Sydney, as specified in record **552-5**.

In one embodiment, validation table **308** may be split into two tables, one for the validation of TNs and one for time-zone offset. In such an embodiment, the table for validating TNs (e.g., a "homing plan") may include country code field **512**, area code field **514**, geographic name field **516**, TN minimum length field **518**, and/or TN maximum length field **520**, for example. The table for determining the time-zone offset may include country code field **512**, area code field **514**, geographic name field **516**, time-zone offset field **524**, DST range field **526**, and/or DST offset field **528**, for example.

Returning to FIG. **3**, time-zone logic **314** may determine the current time-zone offset for a TN. Time-zone logic **314** may use the information in validation table **308** (e.g., country code field **512**, area code field **514**, geographic name field **516**, time-zone offset field **524**, DST range field **526**, and/or DST offset field **528**) to determine the current time-zone offset. Time-zone logic **314** is discussed in more detail below with respect to FIG. **6**D.

As discussed above, controller **112** may receive TNs from a national regulator for assigning to customers. FIG. **6**A is a flowchart of a process **600**A for the intake of TNs in one embodiment. Process **600**A begins with the receiving of a group or block of TNs (block **602**). For example, a carrier may receive a group of consecutive TNs from a national regulator. The TNs in the received group may be considered "granted" but may not yet be ready for assignment to a customer. In this example, TN table **302-1**, shown in FIG. **4**A, shows a group of consecutive TNs received. As shown, the status of each TN is indicated as "granted." No customer is listed in TN table **302-1** shown in FIG. **4**A because the TNs have not yet been associated with a customer. The history of each TN listed in history field **410**, shown in FIG. **4**A, includes the date each TN was granted to the carrier.

The TNs in the group or block may be validated (block **604**). Validation may include ensuring that the TNs have the right properties, such as the properties listed in validation table **308**, shown in FIG. **5**. For example, the TNs may be checked to determine whether each TN has the correct length, starts with the correct prefix (e.g., area code), corresponds to the correct country, corresponds to the correct geographic area (e.g., city), etc. A further description of validating TNs is provided below with respect to FIG. **6**C.

An order may be received regarding a TN in the group of TNs (block **608**). For example, after grant, an order may include making the TNs available for allocation to customers. In this case, information about each TN may be propagated to switches in the carrier's network as well as to the switches of other carriers' networks. In this way, should a telephone call be placed to a TN in the group of TNs, a call would be routed to the appropriate carrier even though it may not yet be assigned to a customer. Before or during the processing of the order, each TN may be validated again (block **610**) to ensure that the TN has the proper properties.

The TN table may be updated (block **612**). As shown in TN table **302-2** (FIG. **4**B), as a result of the order discussed above with respect to block **608**, the status (stored in status field **404**) for each TN has been changed to "available." Further, for each updated record in TN table **302-2**, an update flag may be switched from "NO" to "YES" (block **614**). In one embodiment the entire TN table **302** may be associated with a single update field that is switched from "NO" to "YES" when any record **452-***x* is updated (block **614**). Update flag field **406** may allow a separate process (e.g., a parallel process or thread) to run an analysis for generating reports or displaying information to the user. Such a process to run the analysis is described in more detail below with respect to FIG. **6**B. In one embodiment, that process may also reset the update flags to "NO." For example, as shown in TN table **302-3** in FIG. **4**C, the update flag field **406** of record **452-1** has been reset from "YES" to "NO."

Process **600**A may loop and another TN order may be received (block **608**). For example, the customer associated with premises **122-1** may contact the carrier and have TNs assigned to it. In this case, the received order (block **608**) associates the TN with the customer's location and/or devices **110-***x*. In this case, information about the association may be propagated to switches and equipment in network **100** for proper routing of the call. Before or during the processing of the order, each TN may be validated again (block **610**) to ensure that the TN has the proper properties. A further description of validating TNs is provided below with respect to FIG. **6**C.

TN table **302-2** may be updated (block **612**) to associate the customer with the TNs, as shown in TN table **302-3** in FIG. **4**C. In the current example, TN table **302-3** indicates that the following three numbers are associated with the customer in premises **122-1**: 2018917242, 2018917243, and 2018917244. In the current example, records **452-4**, **452-5**, and **453-6** are updated so that the flags corresponding to the allocated TNs are set to "YES." An update flag of "YES" indicates to a process, discussed below, that an analysis for reporting and display purposes may be run.

As discussed above, a process for analyzing TNs for reporting and display purposes may run when an update occurs to TN table **302** (e.g., as indicated in update flag field **406**). FIG. **6**B is a flowchart of a process **600**B for analyzing TN tables for display and for reporting in one embodiment. In one embodiment, process **600**B may include multiple threads. In FIG. **6**B, for example, process **600**B includes a first thread **620** and a second thread **622**. Each thread may operate on different groups of TNs. For example, thread **620** may operate on TN table **302** and thread **622** may operate on a different TN table. Further, threads **620** and **622** may operate in parallel to process **600**A described above with respect to FIG. **6**A.

Process **600**B begins with the selection of a TN table (block **624**). For example, thread **620** may select TN **302**. If an update flag is set (e.g., if an update flag is YES) (block **626**: YES), then the thread may calculate a range table. In the example where thread **620** has selected TN table **302-2** (shown in FIG. **4**B), if any record stores a YES in update flag field **406**, then thread **620** calculates a range table.

For example, if TN table **302** is in the state shown in FIG. **4**A (e.g., TN table **302-1**), then process thread **620** determines that there is no update flag set (block **626**: NO), and thread **620** may select another, different TN table (block **624**). On the other hand, if TN table **302** is in the state shown in FIG. **4**B (e.g., TN table **302-2**), then thread **620** determines that an update flag has been set (e.g., update flag field **406** includes a YES in record **452-1**) (block **626**: YES). Therefore, thread **620** would proceed to calculate a range table (block **628**). In this case, thread **620** may generate range table **306-1** as shown in FIG. **4**D and described above. As another example, if TN table **302** is in the state shown in FIG. **4**C (e.g., TN table **302-3**), then thread **620** determines that an update flag is set (e.g., update flag field **406** includes a YES in record **452-4**) (block **626**: YES). In this case, thread **620** may generate a range table **306-2** as shown in FIG. **4**E and described above. The update flags are reset (block **630**) after, for example, the range table is calculated. In this fashion, thread **620** (or

another thread in process **600**B) does not calculate a range table for a TN block unnecessarily. In the case of generating range table **306-1**, the update flags in records **452-1** through **452-9** may be reset to "NO." In the case of generating range table **306-2**, the update flags in **452-4** through **452-6** may be reset to "NO."

Having generated range table **306**, the information in TN table **302** may more easily be displayed, analyzed, and reported. Further, process **600**A may be decoupled from process **600**B (e.g., different running threads). This decoupling may allow for rapid updating of TN table **302** without having to wait for an analysis process (e.g., process **600**B) to run, for example.

As discussed above, process **600**A may validate TNs (e.g., blocks **604** and **610**). Process **600**B may also validate TNs. FIG. **6**C is a flowchart of an exemplary process **600**C for validating TNs in one embodiment. Controller **112** may perform process **600**C. As shown, process **600**C begins with receipt of a TN for validating (block **640**). Other information may be received along with the TN, such as the geographic location, the country code, and/or the line type (block **642**). This information may correspond to the information stored in validation table **308** (e.g., country code field **512**, area code field **514**, geographic name field **516**, and/or line type field **522**).

The validation table is queried (block **644**) with the information received with respect to blocks **640** and **642**. Process **600**C determines if the information received (e.g., with respect to blocks **640** and **642**) is consistent with a valid TN. The area code and/or geographic area of the received TN may be checked against validation table **308** for consistency. For example, the area code may be checked to determine if it is correct (e.g., if the received area code/received geographic code pair match an entry in validation table **308**). If the area code of the TN is not correct (block **646**: NO), then a validation error is indicated (block **652**).

The length of the received TN may also be checked against validation table **308** for consistency. If the length is not correct (e.g., shorter than the minimum length or longer than the maximum length) (block **648**: NO), then a validation error code is also indicated (block **652**). If the length of the TN is correct (block **648**: YES) and the area code is correct (block **646**: YES), then a successful validation is indicated (block **650**).

A TN may be validated at any time during processes **600**A, **600**B, or other processes not disclosed herein. Validation may help eliminate human error and/or programming error when generating and/or updating TN table **302** and/or range table **306**, for example.

As discussed above, the time-zone offset for a particular TN may be calculated. Such a calculation may be used for some orders, such as orders discussed above with respect to block **608** of process **600**A. For example, the time-zone offset may be determined when a TN is being ported from one carrier to another. FIG. **6**D is a flowchart of a process **600**D for determining the time-zone offset for a TN. Process **600**D may begin with the determination of an area code for the TN (block **662**). For example, a TN being ported may have the area code of "09846." The geographical location of the area code may also be determined (block **664**). In the current example, process **600**D may query validation table **308** to determine that the area code "08946" corresponds to Sydney. In this example, the country associated with the TN may already be known to process **600**D or process **600**D may query validation table **308** with the numerical country code. The operator may also confirm with the customer that the TN is associated with the geographic location determined by process **600**D. For example, the operator may ask the customer, "Do you live in Sydney?"

Whether daylight saving time applies or not may be determined (block **666**). In the current example, the current date and time may be compared to the DST range stored in field **526** for the corresponding area code and/or geographic region. In the case of record **552-5** (corresponding to area code 08946), daylight saving time applies between Oct. 2, 2011 and Apr. 1, 2012.

The time-zone offset may be determined (block **668**). If the current time/date (determined at block **666**) is in the DST range, then the offset in DST time-zone offset field **528** applies (block **668**). If the current time/date (e.g., determined at block **666**) is not in the DST range, then the offset in time-zone offset field **524** applies (block **668**). For example, if the current date is Oct. 1, 2011, then, in the current example, DST is not being employed and the DST offset is +10 hours from GMT, as indicated in time-zone offset in field **524** of record **552-5**. If the current date is Oct. 5, 2011, on the other hand, then in the current example, DST is currently being employed and the DST offset is +11 hours from GMT, as indicated in DST offset in field **528** of record **552-5**.

In one embodiment, the geographical location of the area code does not have to be determined (block **664**). In this embodiment, the link from the area code to the offset can be determined (e.g., the values linked) without reference to the geographic location stored in geographic name field **516**.

In the preceding specification, various preferred embodiments have been described with reference to the accompanying drawings. It will, however, be evident that various modifications and changes may be made thereto, and additional embodiments may be implemented, without departing from the broader scope of the invention as set forth in the claims that follow. The specification and drawings are accordingly to be regarded in an illustrative rather than restrictive sense.

While series of blocks have been described above with respect to different processes, the order of the blocks may differ in other implementations. Moreover, non-dependent acts may be performed in parallel.

It will be apparent that aspects of the embodiments, as described above, may be implemented in many different forms of software, firmware, and hardware in the embodiments illustrated in the figures. The actual software code or specialized control hardware used to implement these embodiments is not limiting of the invention. Thus, the operation and behavior of the embodiments of the invention were described without reference to the specific software code—it being understood that software and control hardware may be designed to the embodiments based on the description herein.

Further, certain portions of the invention may be implemented as logic that performs one or more functions. This logic may include hardware, such as an application specific integrated circuit, a field programmable gate array, a processor, or a microprocessor, or a combination of hardware and software.

No element, act, or instruction used in the description of the present application should be construed as critical or essential to the invention unless explicitly described as such. Also, as used herein, the articles "a" and the term "one of" are intended to include one or more items. Further, the phrase "based on" is intended to mean "based, at least in part, on" unless explicitly stated otherwise.

What is claimed is:

1. A system comprising:

a network device, associated with a communications service provider, including a memory to store:

a first database including a plurality of records, wherein each record in the first database stores a telephone number (TN) and multiple data fields, including a first data field identifying a current assignment status and a second data field identifying an assignment status history of the corresponding TN with respect to assignment by the communications service provider, wherein the first database stores in a single update field for an entirety of the plurality of records an indicator to indicate whether any one of the plurality of records in the first database was updated in response to a change to data in one or more of the multiple data fields; and

a second database having a plurality of records, wherein each record in the second database indicates a range of consecutive TNs from the first database having a same assignment status history of the TNs that includes a first assignment status at a first date and a second assignment status at a second date, wherein the first assignment status and the second assignment status differ; and

one or more processors to:

run a first thread to update the one of the plurality of records in the first database and to indicate in the stored indicator that the one of the plurality of records in the first database was updated;

run a second thread, different from the first thread, to:

generate the second database from the first database in response to the stored indicator indicating that the one of the plurality of records in the first database was updated, and

reset the stored indicator to indicate that none of the plurality of records in the first database has been updated since the generation of the second database.

2. The system of claim **1**, wherein the second thread generates the second database from the first database in response to a change being made to data in any one of the multiple data fields of any of the plurality of records in the first database.

3. The system of claim **1**, wherein the multiple data fields include a third data field identifying customer data associated with the corresponding TN, and

wherein each of the consecutive TNs has the customer data in common.

4. The system of claim **3**, wherein the customer data does not identify a customer.

5. The system of claim **1**, wherein the first assignment status indicates that the TNs were granted at the first date and the second assignment status indicates the TNs were made available at the second date, and

wherein the assignment status history includes a third assignment status at a third date, wherein the third assignment status indicates that the TNs were allocated at the third date.

6. A system comprising:

a network device, associated with a communications service provider, including a memory to store:

a first database including a plurality of records, wherein each record in the first database stores multiple data fields, including an area code, a maximum length for a telephone number (TN) corresponding to the area code, a minimum length for the TN corresponding to the area code, and an assignment status history of the TN with respect to assignment by the communications service provider, wherein the first database stores in a single update field for an entirety of the plurality of records an indicator to indicate whether any one of the records in the first database was updated in response to a change to data in one or more of the multiple data fields, and

a second database having a plurality of records, wherein each record in the second database indicates a range of consecutive TNs from the first database having a same assignment status history that includes multiple statuses on respective dates that differ, with respect to each of the consecutive TNs being granted, being available, or being allocated; and

one or more processors to:

validate a length of a received TN against information stored in one or more of the multiple data fields in the first database,

run a first thread to update the one of the plurality of records in the first database and to indicate that the one of the plurality of records in the first database was updated, and

run a second thread, different from the first thread, to:

generate the second database from the first database in response to the stored indicator indicating that the one of the plurality of records in the first database was updated, and

reset the indicator to indicate that none of the plurality of records in the first database has been updated since the generation of the second database.

7. The system of claim **6**, wherein each record in the first database stores information indicating a geographic name or region associated with the TN corresponding to the area code.

8. The system of claim **7**, wherein the one or more processors validate the received TN by comparing a geographic area associated with the received TN and an area code associated with the received TN to the geographic name and area code stored in the first database.

9. The system of claim **8**, wherein the one or more processors validate the received TN by determining whether a length of the received TN is greater than or equal to the minimum length stored in the first database and whether the length of the received TN is shorter than or equal to the maximum length stored in the first database.

10. The system of claim **9**,

wherein the memory is configured to store a database including telephone number area codes, associated time-zone offsets for each area code, and an indication of when and whether a geographic area associated with area code employs daylight saving time; and

wherein the one or more processors are configured to determine an area code associated with a received telephone number, query the database to determine whether the determined area code is associated with a geographic area currently employing daylight saving time, and determine a time-zone offset based on the determined area code and the determination of whether the geographic area associated with the determined area code is currently employing daylight saving time.

11. The system of claim **6**, wherein each record in the first database stores information indicating whether the TN corresponding to the area code is associated with a mobile line or a fixed line.

12. The system of claim **11**, wherein each record in the first database stores information indicating a geographic name or region of the TN corresponding to the area code.

13. The system of claim **6**, wherein the multiple data fields include a current assignment status of the TN with respect to the TN being granted, being available, or being allocated, and

wherein each of the consecutive TNs has the current assignment status in common.

14. The system of claim 6, wherein the multiple data fields include customer data associated with the TN, and

wherein each of the consecutive TNs has the customer data in common.

15. The system of claim 14, wherein the customer data does not identify a customer.

16. A computer-implemented method comprising:

executing a first thread to update at least one data field in a record in a first database and to store an indicator, in a single update field for an entirety of a plurality of records in the first database in response to the update, wherein the first database includes a plurality of records, each record in the first database storing a telephone number (TN) and a number of data fields, including a first data field identifying an assignment status of the corresponding TN with respect to assignment by a communications service provider and a second data field identifying an assignment status history; and

executing a second thread, different from the first thread, to:

generate a second database from the first database in response to the stored indicator in the first database, wherein the second database stores a plurality of records, wherein each record in the second database indicates a range of consecutive TNs from the first database having a same assignment status history that includes multiple statuses on respective dates that differ, with respect to each of the consecutive TNs being granted, being available, or being allocated.

17. The computer-implemented method of claim 16, wherein the second thread generates the second database from the first database in response to a change being made to data in any one of the number of data fields of any of the plurality of records stored in the first database.

18. The computer-implemented method of claim 16,

wherein each record in the first database stores a name of a customer associated with the corresponding TN, and

wherein each record in the second database indicates a range of consecutive TNs from the first database having a same customer name.

19. The computer-implemented method of claim 16, further comprising:

determining an area code associated with a telephone number, wherein the area code is associated with a geographic location;

determining whether the geographic location associated with the area code is currently employing daylight saving time; and

determining a time-zone offset based on the area code and the determination of whether the geographic location associated with the area code is currently employing daylight saving time.

20. The computer-implemented method of claim 19,

wherein determining the time-zone offset includes querying a database to determine, based on the area code, the time-zone offset based on Greenwich Mean Time (GMT); and

wherein determining whether the geographic location associated with the area code is currently employing daylight saving time includes querying a database to determine whether the area code is associated with daylight saving time.

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